



F-35 Joint Strike Fighter (JSF) Program: Background and Issues for Congress

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Summary

The F-35 Joint Strike Fighter (JSF), also called the Lighting II, is a new strike fighter being procured in different versions by the Air Force, Marine Corps, and Navy. The F-35 program is the Department of Defense's (DOD's) largest weapon procurement program in terms of total estimated acquisition cost. Current DOD plans call for acquiring a total of 2,456 JSFs for the Air Force, Marine Corps, and Navy at an estimated total acquisition cost (as of December 31, 2007) of about \$246 billion in constant (i.e., inflation-adjusted) FY2009 dollars. Procurement of F-35s began in FY2007. Hundreds of additional F-35s are to be purchased by several U.S. allies.

The administration's proposed FY2010 defense budget requests a total of about \$10.4 billion in Air Force and Navy research and development funding and procurement funding for the F-35 program, including about \$3.6 billion in Air Force and Navy research and development funding and about \$6.8 billion in Air Force and Navy procurement funding. The proposed FY2010 budget would fund the procurement of 10 F-35As for the Air Force, 16 F-35Bs for the Marine Corps, and four F-35Cs for the Navy. (Development and procurement of Marine Corps aircraft are funded through the Navy's budget.)

The administration's proposed FY2010 defense budget also proposes to terminate the F-35 alternate engine program, which is intended to develop the General Electric/Rolls-Royce F136 engine as an alternative to the Pratt and Whitney F135 engine that currently powers the F-35. The George W. Bush administration proposed terminating the alternate engine program in FY2007, FY2008, and FY2009, but Congress rejected these proposals and each year provided funding for the program's continuation.

The issues for Congress for FY2010 are whether to approve, reject, or modify the administration's funding request for the F-35 program, and whether to approve or reject the administration's proposal to terminate the alternate engine program. Congress' decisions on these matters will affect DOD capabilities and funding requirements and the tactical aircraft manufacturing industrial base.

The FY2010 defense authorization bill as reported by the House Armed Services Committee on June 18, 2009 (H.R. 2647) recommends reducing procurement of F-35s by two aircraft from the administration's request, and adding \$603 million in funding for the F-35 alternate engine program. H.R. 2647 as reported by the House contains a number of legislative provisions relating to the F-35 program, including a provision relating to the alternate engine program. This report will be updated as events warrant.

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Introduction

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The issues for Congress for FY2010 are whether to approve, reject, or modify the administration's funding request for the F-35 program, and whether to approve or reject the administration's proposal to terminate the alternate engine program. Congress' decisions on these matters will affect DOD capabilities and funding requirements and the tactical aircraft manufacturing industrial base.

Background

The F-35 In Brief

In General

The F-35 was conceived as a relatively affordable 5th-generation strike fighter¹ that could be procured in three highly common versions for the Air Force, the Marine Corps, and the Navy,² so

¹ Fifth-generation aircraft incorporate the most modern technology, and are considered to be generally more capable than earlier-generation (e.g., 4th-generation and below) aircraft. Fifth-generation fighters combine new developments such as thrust vectoring, composite materials, supercruise (the ability to cruise at supersonic speeds without using engine afterburners), stealth technology, advanced radar and sensors, and integrated avionics to greatly improve pilot situational awareness. Currently, only the Air Force F-22 air superiority fighter and the F-35 are considered fifth-generation aircraft. Russia reportedly has a fifth-generation fighter under development.

Strike fighters are dual-role tactical aircraft that are capable of both air-to-ground (strike) and air-to-air (fighter) combat (continued...)

that the three services could avoid the higher costs of developing, procuring, and operating and supporting three separate tactical aircraft designs to meet their similar but not identical operational needs.³

DOD states that the F-35 program “was structured from the beginning to be a model of acquisition reform, with an emphasis on jointness, technology maturation and concept demonstrations, and early cost and performance trades integral to the weapon system requirements definition process.”⁴

All three versions of the F-35 will be single-seat aircraft with supersonic dash capability and some degree of stealth. The three versions will vary somewhat in their combat ranges and payloads (see **Appendix**). All three are to carry their primary weapons internally to maintain a stealthy radar signature. Additional weapons can be carried externally. The Air Force states that:

The F-35 program will develop and deploy a family of highly capable, affordable, fifth generation strike fighter aircraft to meet the operational needs of the Air Force, Navy, Marine Corps, and Allies with optimum commonality to minimize life cycle costs. The F-35 was designed from the bottom-up to be our premier surface-to-air missile killer and is uniquely equipped for this mission with cutting edge processing power, synthetic aperture radar integration techniques, and advanced target recognition. The F-35 also provides “leap ahead” capabilities in its resistance to jamming, maintainability, and logistic support.⁵

Air Force Version

The Air Force is procuring the F-35A, a conventional takeoff and landing (CTOL) version of the aircraft. F-35As are to replace Air Force F-16 fighters and A-10 attack aircraft. The F-35A is intended to be a more affordable complement to the Air Force’s new F-22 Raptor air superiority fighter (which is replacing the service’s aging F-15 air superiority fighters.) Compared to the F-22, the F-35A is not quite as stealthy and not as capable in air-to-air combat, but it is still very capable in both these areas, and is also very capable in air-to-ground combat. The F-35 is more stealthy and more capable in air-to-air and air-to-ground combat than the F-16. If the F-15/F-16 combination represented the Air Force’s earlier-generation “high-low” mix of air superiority fighters and more-affordable dual-role aircraft, then the F-22/F-35A combination might be

(...continued)

operations.

² The program’s operational requirements call for 70% to 90% commonality between all three versions. Many of the three versions’ high-cost components—including their engines, avionics, and major airframe structural components—are common.

³ Secretary of Defense William Cohen stated in 2000 that the JSF’s joint approach “avoids the three parallel development programs for service-unique aircraft that would have otherwise been necessary, saving at least \$15 billion.” (Letter from Secretary of Defense William S. Cohen to Rep. Jerry Lewis, June 22, 2000. The text of letter made available by *Inside the Air Force* on June 23, 2000.)

⁴ Department of Defense. *Selected Acquisition Report (SAR)[for] F-35 (JSF)*, December 31, 2007, p. 4.

⁵ Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5) [and] Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ) Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8) May 20, 2009, p. 10.

viewed as the Air Force's intended future high-low mix of air superiority fighters and more-affordable dual-role aircraft.⁶ The Air Force states that:

Both the F-22A and the F-35 represent our latest generation of fighter aircraft. We need both aircraft to maintain the margin of superiority we have come to depend upon, the margin that has granted our forces in the air and on the ground freedom to maneuver and to attack. The F-22A and F-35 each possess unique, complementary, and essential capabilities that together provide the synergistic effects required to maintain that margin of superiority across the spectrum of conflict. The OSD-led 2006 QDR Joint Air Dominance study underscored that our Nation has a critical requirement to recapitalize TACAIR forces. Legacy 4th generation aircraft simply cannot survive to operate and achieve the effects necessary to win in an integrated, anti-access environment.⁷

The Department of the Navy states that:

The commonality designed into the joint F-35 program will minimize acquisition and operating costs of Navy and Marine Corps tactical aircraft, and allow enhanced interoperability with our sister Service, the United States Air Force, and the eight partner nations participating in the development of this aircraft. This aircraft will give combatant commanders greater flexibility across the range of military operations. A true fifth generation aircraft, the F-35 will enhance precision strike capability through unprecedented stealth, range, sensor fusion, improved radar performance, combat identification and electronic attack capabilities compared to legacy platforms. It will also add sophisticated electronic warfare capabilities, as compared to the legacy platforms it will replace, and will tie together disparate units scattered across the battlefield, in real time.⁸

Marine Corps Version

The Marine Corps is procuring the F-35B, a short takeoff and vertical landing (STOVL) version of the aircraft.⁹ F-35Bs are to replace Marine Corps AV-8B Harrier vertical/short takeoff and landing (VSTOL) attack aircraft and F/A-18A, C, and D strike fighters, which are CTOL aircraft. The F-35B and the V-22 Osprey tilt-rotor aircraft¹⁰ are central to achieving a long-term Marine

⁶ The term high-low mix refers to a force consisting of a combination of high-cost, high-capability aircraft and lower-cost, more-affordable aircraft. Procuring a high-low mix is a strategy for attempting to balance the goal for having a certain minimum number of very high capability tactical aircraft to take on the most challenging projected missions and the goal of being able to procure tactical aircraft sufficient in total numbers within available resources to perform all projected missions.

⁷ Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5) [and] Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ) Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8) May 20, 2009, pp. 7-8.

⁸ Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, Before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy's Aviation Procurement Program, May 19, 2009, p. 1.

⁹ To permit STOVL operations, the F-35B has an engine exhaust nozzle at the rear than can swivel downward, and a mid-fuselage lift fan connected to the engine that blows air downward to help lift the forward part of the plane.

¹⁰ For more on the V-22 program, see CRS Report RL31384, *V-22 Osprey Tilt-Rotor Aircraft: Background and Issues for Congress*, by Ronald O'Rourke.

Corps goal for phasing out the service's CTOL aircraft and fielding an all-VSTOL Marine Corps aviation capability. The Marine Corps decided to not procure F/A-18E/F strike fighters¹¹ and instead wait for the F-35B in part because the F/A-18E/F is a CTOL aircraft. The Department of the Navy states that:

The F-35B Short Take-off Vertical Landing (STOVL) variant combines the multi-role versatility and strike fighter capability of the legacy F/A-18 with the basing flexibility of the AV-8B. Having these capabilities in one aircraft will provide the joint force commander and the MAGTF [Marine Air-Ground Task Force] commander unprecedented strategic and operational agility.

The Marine Corps' tactical aviation (TACAIR) fixed-wing platforms, used for direct support to our ground combat Marines in the fight, are the AV-8B Harrier, the F/A-18 A+/C/D Hornet and the EA-6B Prowler. These aircraft are approaching the end of their planned service lives, and the Marine Corps, through careful service life extension programs, has managed these legacy platforms to bridge our aviation force until future airframes come on line. The Marines' F-35B will replace both the AV-8B and F/A-18 A+/C/D, as well as fill a large portion of the EA-6B mission as part of a networked system of systems. The Marine Corps intends to leverage the F-35B's sophisticated sensor suite and very low observable (VLO), fifth generation strike fighter capabilities, particularly in the area of data collection, to support the Marine Air Ground Task Force (MAGTF) well beyond the abilities of today's strike and EW assets.¹²

Navy Version

The Navy is procuring the F-35C, a carrier-suitable CTOL version of the aircraft.¹³ The F-35C is also known as the CV version of the F-35, with CV meaning aircraft carrier. The Navy in the future plans to operate carrier air wings featuring a strike fighter combination of F/A-18E/Fs (which the Navy has been procuring since FY1997) and F-35Cs. The F/A-18E/F is generally considered a fourth-generation strike-fighter. (Some F/A-18E/F supporters argue that it is a "fourth-plus" or "4.5" generation strike fighter because it incorporates some fifth-generation technology, particularly in its sensors.) The F/A-18E/F incorporates a few stealth features, but the F-35C is stealthier. The F/A-18E/F is less expensive to procure than the F-35C. In contrast to the Air Force, which has operated stealthy bombers and fighters for years, the F-35C is to be the Navy's first considerably stealthy aircraft. The Department of the Navy states that:

The F-35C carrier variant (CV) complements the F/A-18E/F Block II and EA-18G in providing survivable, long-range strike capability and persistence over the battlefield. The F-

¹¹ For more on the F/A-18E/F program, see CRS Report RL30624, *Navy F/A-18E/F and EA-18G Aircraft Procurement and Strike Fighter Shortfall: Background and Issues for Congress*, by Ronald O'Rourke.

¹² Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, Before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy's Aviation Procurement Program, May 19, 2009, pp. 1-2.

¹³ Features for carrier suitability include, among other things, strengthened landing gear, a strengthened airframe, and an arresting hook so as to permit catapult launches and arrested-wire landings, as well as folding wing tips for more compact storage aboard ship.

35 will give the ESG and CSG commanders a survivable “Day-One” strike capability in a denied access environment that can not be accomplished by current legacy aircraft.¹⁴

Engine

The F-35 is powered by the Pratt and Whitney F135 engine, which was derived from the F-22’s Pratt and Whitney F119 engine. Consistent with congressional direction in 1996, DOD established an alternative engine program with the General Electric/Rolls-Royce Fighter Engine Team to develop the F136 engine as a second engine to compete with the F135 for JSF production and operations and support (O&S) contracts. The George W. Bush administration proposed terminating the alternate engine program in FY2007, FY2008, and FY2009,¹⁵ but Congress rejected these proposals and each year provided funding for the program’s continuation.

Program Origin and Acquisition Milestones

The JSF program began in the early- to mid-1990s.¹⁶ Three different designs for the aircraft were proposed by Boeing, Lockheed, and McDonnell Douglas (the last teamed with Northrop Grumman and British Aerospace). On November 16, 1996, the Defense Department announced that Boeing and Lockheed Martin had been chosen to compete in the Concept Demonstration Phase (CDP) of the program, with Pratt and Whitney providing propulsion hardware and engineering support. Boeing and Lockheed were each awarded contracts to build and test-fly two aircraft to demonstrate their competing concepts for all three planned JSF variants.

The competition between Boeing and Lockheed Martin was closely watched: Given the size of the JSF program and the expectation that the JSF might be the last fighter aircraft program that DOD would initiate for many years, DOD’s decision on the JSF program was expected to shape the future of both U.S. tactical aviation and the U.S. tactical aircraft industrial base.

¹⁴ Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, Before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy’s Aviation Procurement Program, May 19, 2009, p. 1.

¹⁵ See CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Christopher Bolkcom.

¹⁶ The JSF program emerged in late 1995 from the Joint Advanced Strike Technology (JAST) program, which began in late 1993 as a result of the Clinton administration’s Bottom-Up Review (BUR) of U.S. defense policy and programs. The BUR envisaged the JAST program as a replacement for two other tactical aircraft programs that were being terminated (the A-12 program, which was intended to provide a stealthy new carrier-based attack plane to replace the Navy’s aging A-6 carrier-based attack planes, and the multi-role fighter [MRF], which was the Air Force had considered as a replacement for its F-16 fighters).

In 1995, in response to congressional direction, a program led by the Defense Advanced Research Projects Agency (DARPA) to develop an advanced short takeoff and vertical landing (ASTOVL) aircraft was incorporated into the JAST program. This opened the way for Marine Corps and UK participation in the JAST program, since the Marine Corps and the UK were interested procuring a new STOVL aircraft to replace their aging Harrier STOVL attack aircraft. The name of the program was then changed to Joint Strike Fighter (JSF) to focus on joint development and production of a next-generation fighter/attack plane.

A Joint Operational Requirements Document (JORD) for the F-35 program was issued in March 2000 and revalidated by DOD’s Joint Requirements Oversight Council (JROC) in October 2001.

In October 2001, DOD selected the Lockheed design as the winner of the competition, and the JSF program entered the System Development and Demonstration (SDD) phase. SDD contracts were awarded to Lockheed Martin (for the aircraft) and Pratt and Whitney (for the aircraft's engine). General Electric continued technical efforts related to the development of a second engine source for competition in the program's production phase.¹⁷

The first flights of the F-35A and F-35B occurred in the first quarter of FY2007 and the third quarter of FY2008, respectively.¹⁸ Under the FY2010 budget submission, the first flight of an optimized design for the F-35A (i.e., a slightly changed design for the F-35A) is scheduled for the third quarter of FY2009, and the first flight of the F-35C is scheduled for the first quarter of FY2010. The F-35A, F-35B, and F-35C are scheduled to achieve Initial Operational Capability (IOC) in March 2013, March 2012, and March 2015, respectively. Note that the scheduled IOC of the F-35B is a year earlier than that of the F-35A.

Procurement Quantities

Planned Total Procurement Quantities

As of December 31, 2007, the F-35 program included a planned total of 2,456 aircraft—13 research and development aircraft and a planned total of 2,443 production aircraft. The 2,443 production aircraft include 1,763 F-35As for the Air Force and 680 F-35Bs and Cs for the Marine Corps and Navy, with exact numbers of Bs and Cs to be determined.¹⁹ These planned production totals are subject to review in the Quadrennial Defense Review (QDR) that is to be reported to Congress with the submission of the proposed FY2011 defense budget in February 2010. A June 3, 2009, press report states:

Air Force Chief of Staff Norton Schwartz today signaled that the service's requirement for 1,763 F-35 Joint Strike Fighters is being examined during the comprehensive Quadrennial Defense Review now under way. Whether the Air Force ultimately buys more or fewer F-35s than planned depends on that review of military capabilities and requirements, the four-star general told the House Defense Appropriations Subcommittee. Indeed, the Air Force's plan to field a total of 2,250 fighters, both old and new, is also under review, according to Schwartz.

¹⁷ On October 24, 2001, the Defense Acquisition Board (DAB) held a Milestone B review for the program. (Milestone B approval would permit the program to enter the SDD phase.) On October 25, 2001, the Secretary of Defense certified to Congress (in accordance with Section 212 of the FY2001 defense authorization act [H.R. 4205/P.L. 106-398 of October 30, 2000]) that the program had successfully completed the CDP exit criteria and demonstrated sufficient technical maturity to enter SDD. On October 26, 2001, the SDD contracts were awarded to Lockheed and Pratt and Whitney.

¹⁸ A Preliminary Design Review (PDR) for the F-35 program was conducted in April 2003, and Critical Design Reviews (CDRs) were held for the F-35A, F-35B, and F-35C in February 2006 (F-35A and F-35B) and June 2007 (F-35C).

¹⁹ In 1996, preliminary planning estimated over 3,000 F-35s for DOD and the UK: 2,036 for the Air Force, 642 for the Marines, 300 for the U.S. Navy, and 60 for the Royal Navy. In May 1997, the QDR recommended reducing projected DOD procurement from 2,978 to 2,852: 1,763 for the Air Force, 609 for the Marines, and 480 for the Navy. (Quadrennial Defense Review Cuts Procurement in FY1999, 2000, *Aerospace Daily*, May 20, 1997, p. 280.) In 2003, the Department of the Navy (DON) reduced its planned procurement of 1,089 F-35s to 680 aircraft as part of the Navy/Marine Corps Tactical Aviation Integration Plan. (See CRS Report RS21488, *Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress*, by Christopher Bolkcom and Ronald O'Rourke.)

“It could end up being less,” he said, adding, “if that’s the case, we will still have a predominately F-35” force. Still, Schwartz said he expects to have “well over” 1,500 F-35s.²⁰

Annual Procurement Quantities

Procurement of F-35s began in FY2007. **Table 1** shows actual F-35 procurement quantities through FY2009 and requested procurement quantities for FY2010. The figures in the table do not include 13 research and development aircraft procured with research and development funding.

Table 1. Annual F-35 Procurement Quantities

(Figures shown are for production aircraft; table excludes 13 research and development aircraft)

Type	FY07	FY08	FY09	FY10 request
F-35A (USAF)	2	6	7	10
F-35B (USMC)	0	6	7	16
F-35C (USN)	0	0	0	4
TOTAL	2	12	14	30

Source: Prepared by CRS based on DOD data.

DOD plans have contemplated increasing the procurement rate of F-35As for the Air Force to a sustained rate of 80 aircraft per year by FY2015, and completing the planned procurement of 1,763 F-35As by about FY2034. DOD plans have also contemplated increasing the procurement rate of F-35Bs and Cs for the Marine Corps and Navy to a combined sustained rate of 50 aircraft per year by about FY2014, and completing the planned procurement of 680 F-35Bs and Cs by about FY2025.

Program Management

The JSF program is jointly staffed and managed by the Department of the Air Force and the Department of the Navy (DON). Service Acquisition Executive (SAE) responsibility alternates between the two departments. When the Air Force has SAE authority, the F-35 program director is from DON, and vice versa. The Air Force resumed SAE authority in April 2009.²¹

²⁰ “Air Force Need For F-35s Under Review,” *National Journal’s CongressDailyPM*, June 3, 2009.

²¹ In 2004, appropriations conferees followed a House recommendation to direct DOD to review this alternative management arrangement. House appropriators believed that “management of program acquisition should remain with one Service, and that the U.S. Navy, due to its significant investment in two variants of the F-35 should be assigned all acquisition executive oversight responsibilities.” (H.Rept. 108-553 [H.R. 4613], p. 234) Conferees directed that DOD submit a report on the potential efficacy of this change. Prior to the release of the DOD report, former Air Force Chief of Staff General John Jumper was quoted as saying that he also supported putting one service in charge of JSF program acquisition. (Elizabeth Rees, “Jumper Supports Single Service Retaining JSF Acquisition Oversight,” *Inside the Air Force*, August 6, 2004.) However, General Jumper highlighted the significant investment the Air Force was making in the JSF program in response to the congressional language favoring the Navy. In DOD’s response to Congress, the report noted the current arrangement ensures one Service does not have a “disproportionate voice” when it comes to program decisions and that the current system is “responsive, efficient, and in the best interests of the success of the (continued...)”

International Participation

The F-35 program features a significant amount of international participation, making it DOD's largest international cooperative program. Allied participation has been actively pursued by DOD as a way to defray some of the cost of developing and producing the aircraft, and to "prime the pump" for export sales.²² Allies in turn view participation in the F-35 program as an affordable way to acquire a fifth-generation fighter, technical knowledge in areas such as stealth, and industrial opportunities for domestic firms.

Eight allied countries—the United Kingdom, Canada, Denmark, The Netherlands, Norway, Italy, Turkey, and Australia—are participating in the F-35 program under Memoranda of Understanding (MOUs) in the SDD phase of the program and the Production, Sustainment and Follow-On Development (PSFD) phase of the program. These eight countries have contributed varying amounts of research and development funding to the program, receiving in return various levels of participation in the program.²³ International partners are also assisting with Initial Operational Test and Evaluation (IOT&E), a subset of SDD.²⁴ The eight partner countries are expected to

(...continued)

JSF program." (U.S. Department of Defense, *Report to Congress on Joint Strike Fighter Management Oversight* [forwarded by] Michael W. Wynne, Under Secretary of Defense for Acquisition, Technology and Logistics, December 20, 2004.)

²² Congress insisted from the outset that the JAST program include ongoing efforts by DARPA to develop more advanced STOVL aircraft, opening the way for UK participation in the program.

²³ International participation in the F-35 program is divided into three levels, according to the amount of money a country contributes to the program—the higher the amount, the greater the nation's voice with respect to aircraft requirements, design, and access to technologies gained during development. The UK is the only "Level I" partner, contributing approximately \$2 billion to the SDD phase. UK participation began at the outset of the F-35 program. On December 20, 1995, the U.S. and UK governments signed an MOU on UK participation in the F-35 program as a collaborative partner in the definition of requirements and aircraft design. This MOU committed the UK government to contribute \$200 million toward the cost of the 1997-2001 Concept Demonstration Phase. ("U.S., U.K. Sign JAST Agreement," *Aerospace Daily*, December 21, 1995, p. 451.) On January 17, 2001, the United States and United Kingdom finalized the UK's SDD participation, which equated to approximately 8% of the total SDD phase. Many UK firms, such as British Aerospace and Rolls-Royce, have strong participation in the program.

Level II partners consist of Italy and the Netherlands, contributing \$1 billion and \$800 million, respectively. On June 24, 2002, Italy became the senior Level II partner. ("F-35 Joint Strike Fighter (JSF) Lightning II: International Partners," <http://www.globalsecurity.org/military/systems/aircraft/f-35-int.htm>, accessed on October 3, 2007.) Italy wants to have its own F-35 final assembly line, which would be in addition to a potential F-35 maintenance and upgrade facility. The Netherlands signed on to the F-35 program on June 17, 2002, after it had conducted a 30-month analysis of potential alternatives.

Australia, Denmark, Norway, Canada, and Turkey joined the F-35 program as Level III partners, with contributions ranging from \$125 million to \$175 million. ("Australia, Belgium Enter Joint Strike Fighter Program as EMD Partners," *Inside the Air Force*, April 21, 2000.)

Unlike the SDD phase, PSFD phase does not make any distinction as to levels of participation. Also unlike the bilateral SDD MOUs, there is a single PSFD MOU for all partner nations. In signing the PSFD MOU, partner nations state their intentions to purchase the F-35, including quantity and variant, and a determination is made as to their delivery schedule. PSFD costs will be divided on a "fair-share" based on the programmed purchase amount of the respective nation. So-called "offset" arrangements, considered the norm in defense contracts with foreign nations, usually require additional incentives to compensate the purchasing nation for the agreement's impact to its local workforce. F-35 officials decided to take a different approach, in line with the program's goal to control costs, to avoid offset arrangements and promote competition as much as possible. Consequently, all partner nations have agreed to compete for work on a "best-value" basis and have signed the PSFD MOU.

²⁴ Currently, the UK, Italy, and the Netherlands have agreed to participate in the IOT&E program. UK, the senior F-35 partner, will have the strongest participation in the IOT&E phase. Italy and the Netherlands are contributing a far smaller amount and will take part only in the coalition concept of operations (CONOPS) validation testing. (Telephone (continued...)

purchase more than 700 hundred F-35s, with the United Kingdom being the largest anticipated foreign purchaser.²⁵ Two additional countries—Israel and Singapore—are security cooperation participants outside the F-35 cooperative development partnership,²⁶ and sales to additional countries are possible.²⁷ Some officials have speculated that foreign sales of F-35s might eventually surpass 3,000 aircraft.²⁸

For several years, press reports have indicated that a number of partner nations have threatened to withdraw from the program because of frustrations over workshare and technology transfer issues.²⁹ To more effectively negotiate the terms of their involvement, some European F-35 partners reportedly are attempting to team with others and present a more united position vis-a-vis Lockheed.³⁰

Cost and Funding

Sources of Funding

The F-35 program has received or currently receives funding from:

- the Air Force, Navy, and Defense-Wide research, development, test, and evaluation (RDT&E) accounts;³¹
- additional research and development funding from Non-Treasury Funds (i.e., financial contributions from the eight other countries participating in the F-35 program);

(...continued)

conversation with OSD/AT&L, October 3, 2007.) Other partner nations are still weighing their option to participate in the IOT&E program. The benefits to participation are expedited acquisition of aircraft, pilot training for the test cycle, and access to testing results.

²⁵ Anticipated orders are as follows: UK: 138; Italy: 131; Australia: 100; Turkey: 100; Canada: 88; Netherlands: 85; Denmark: 48; Norway: 48. (Michael Sirak, “F-35 Nations on Track to Sign New MOU, Says JSF Program Office,” *Defense Daily*, November 20, 2006.)

²⁶ DOD offers Foreign Military Sales (FMS)-level of participation in the F-35 program for countries unable to commit to partnership in the program’s SDD phase. Israel and Singapore are believed to have contributed \$50 million each, and they are “Security Cooperative Participants.” (Selected Acquisition Report. Office of the Secretary of Defense for Acquisition. December 31, 2005.) In October 2008, it was reported that the Bush administration had authorized sale of the F-35 to Israel. (Caitlin Harrington. “US approves F-35 sale to Israel.” *Jane’s Defense Weekly*. October 1, 2008) and that Tel Aviv was prepared to spend as much as \$15 billion to procure 25 F-35s. (“Israel Looks to Spend \$15 Billion for CTOL Variant of F-35.” *Defense Daily*. October 1, 2008.)

²⁷ F-35 program officials have discussed the aircraft with the defense staffs of many other allied countries as prospective customers, including Germany, Greece, and Spain.

²⁸ See, for example, Marina Malenic, “F-35 Sales Could Double As Countries Look To Replace Aging Fleets, General Says,” *Defense Daily*, June 18, 2009: 6.

²⁹ See “Norway Signs Industrial Partnership with Eurofighter Consortium,” *Defense Daily*, January 29, 2003; Joris Janssen Lok, “Frustration Mounts Among JSF Partners,” *Jane’s Defense Weekly*, March 24, 2004; Thomas Dodd, “Danish Companies Consider Quitting JSF Programme,” *Jane’s Defence Weekly*, January 9, 2004; Tom Kingston, “Unsatisfied Italy May Cut JSF Participation,” *Defense News*, May 10, 2004; Lale Sariibrahimoglu, “Turkey may withdraw from JSF program,” *Jane’s Defence Weekly*, November 10, 2004.

³⁰ Tom Kingston. “Italy Pushes for Europeanized JSF.” *Defense News*. October 13, 2008.

³¹ The Defense-Wide RDT&E funding occurred in FY1996-FY1998.

- procurement funding from the Air Force and Navy aircraft procurement accounts,³² and
- MilCon funding from the Air Force MilCon account and the Navy and Marine Corps MilCon account.

Estimated Total Program Acquisition Cost and Prior-Year Funding

As of December 31, 2007, the total estimated acquisition cost (the sum of development cost, procurement cost, and military construction [MilCon] cost) of the F-35 program in constant (i.e., inflation-adjusted) FY2009 dollars was about \$246 billion, including about \$47.1 billion in research and development costs, about \$198.4 billion in procurement costs, and about \$496 million in MilCon costs.³³

In then-year dollars (meaning dollars from various years that are not adjusted for inflation), the figures from the preceding paragraph become \$298.8 billion in acquisition costs, including \$44.4 billion in research and development costs, \$254.0 billion in procurement costs, and about \$521 million in MilCon costs.

Like several other DOD acquisition programs, the JSF has experienced cost growth (and also schedule slippage). Since 2002, the total estimated acquisition cost of the F-35 program has increased by roughly \$100 billion due primarily to a one-year extension in the program's SDD phase, a corresponding one-year delay in the start of procurement (from FY2006 to FY2007), revised annual quantity profiles, and revised labor and overhead rates. Much of this increased cost and schedule slippage was incurred to address weight-driven performance issues in the development of the F-35B.

Through FY2009, the F-35 program has received a total of roughly \$44 billion funding in then-year dollars, including roughly \$37 billion in research and development funding, about 6.9 billion in procurement funding, and roughly \$150 million in MilCon funding.

Estimated Unit Costs

The F-35 program as of December 31, 2007 had a program acquisition unit cost (or PAUC, meaning total acquisition cost divided by the 2,456 research and development and procurement aircraft) of about \$100.1 million in constant FY2009 dollars, and an average procurement unit cost (or APUC, meaning total procurement cost divided by the 2,443 production aircraft) of about \$81.2 million in constant FY2009 dollars. Between October 2001 and December 2007, the constant-dollar PAUC and APUC figures have each grown by about 38%.

³² The Navy and Marine Corps are organized under the Department of the Navy, and Marine Corps aircraft development and procurement costs are funded through the Navy's RDT&E and aircraft procurement accounts.

³³ The procurement cost figure of about \$198.4 billion does not include the cost of several hundred additional F-35s that are to be procured other countries that are participating in the F-35 program. The \$198.4-billion figure does, however, assume certain production-cost benefits for DOD aircraft that result from producing these several hundred additional F-35s for other countries.

Manufacturing Locations

Current plans call for the F-35 to be manufactured in several locations. Lockheed will build the aircraft's forward section in Fort Worth, TX. Northrop will build the mid-section in Palmdale, CA, and the tail will be built by BAE Systems in the United Kingdom. Final assembly of these components will take place in Fort Worth. Italy in 2007 reportedly was working with Lockheed and the F-35 program office on the potential of establishing a second final assembly and checkout facility in Italy.³⁴

Proposed FY2010 Budget

FY2010 Funding Request

Table 2 shows the administration's FY2010 request for Air Force and Navy research and development and procurement funding for the F-35 program, along with FY2008 and FY2009 funding levels. The funding figures shown in the table do not include procurement funding for initial spares, MilCon funding, or research and development funding provided by other countries.

Table 2. FY2010 Funding Request for F-35 Program

(Figures in millions of then-year dollars; FY2008 and FY2009 figures shown for reference; figures shown do not include procurement funding for initial spares, MilCon funding, or research and development funding provided by other countries;)

	FY2008		FY2009		FY2010 (request)	
	Funding	Quantity	Funding	Quantity	Funding	Quantity
RDT&E funding						
Air Force	1,939.1	—	1,734.3	—	1,858.1	—
Dept. of Navy	1,848.9	—	1,744.6	—	1,741.3	—
Subtotal	3,788.0	—	3,478.9	—	3,599.4	—
Procurement funding						
Air Force	1,412.1	6	1,660.6	7	2,349.4	10
Dept. of Navy	1,223.6	6 ^a	1,650.1	7 ^b	4,478.0	20 ^c
Subtotal	2,635.7	12	3,310.7	14	6,827.5	30
TOTAL	6,423.7	12	6,789.6	14	10,426.9	30

Source: Prepared by CRS based on DOD data. Figures shown do not include procurement funding for initial spares, MilCon funding, or research and development funding provided by other countries. Air Force funding for initial spares was \$69.8 million in FY2008 and \$60.9 million in FY2009, and \$129.7 million is requested for FY2010. Department of the Navy funding for initial spares was zero in FY2008 and \$32.7 million in FY2009, and \$249.0 million is requested for FY2010. International partner funding for research and development was \$552.7 million in FY2008 and \$250.6 million in FY2009, and is projected to be \$114.1 million in FY2010.

³⁴ Michael Sirak, "F-35 Program May Get First International Orders In Third Production Lot in 2009," *Defense Daily International*, June 22, 2007.

- a. All 6 aircraft are F-35Bs for the Marine Corps.
- b. All 7 aircraft are F-35Bs for the Marine Corps.
- c. Includes 16 F-35Bs for the Marine Corps and 4 F-35Cs for the Navy.

The 10 F-35As requested for FY2010 in the Air Force budget have an estimated procurement cost of \$2,220.3 million, or an average of \$222.0 million each. These aircraft have received \$171.4 million in prior-year advance procurement (AP) funding, leaving another \$2,048.8 million to be funded in FY2010 to complete their estimated procurement cost. The FY2010 Air Force procurement funding request for the F-35 program also includes \$300.6 million in advance procurement funding for 27 F-35As to be procured in future years, and \$129.7 million for F-35A initial spares, bringing the total FY2010 Air Force procurement funding request for the program to \$2,479.1 million. (**Table 2** does not include funding for initial spares, which is why it shows a total of \$2,349.4 million.)

The 16 F-35Bs and four F-35Cs requested for FY2010 in the Department of the Navy budget have a combined estimated procurement cost of \$4,212.1 million, or an average of \$210.6 million each. These aircraft have received \$215.0 million in prior-year AP funding, leaving another \$3,997.0 million to be funded in FY2010 to complete their estimated procurement cost. The FY2010 Department of the Navy procurement funding request for the F-35 program also includes \$481.0 million in advance procurement funding for F-35Bs and Cs to be procured in future years, and \$249.0 million for F-35A initial spares, bringing the total FY2010 Air Force procurement funding request for the program to \$4,727.0 million. (**Table 2** does not include funding for initial spares, which is why it shows a total of \$4,478.0 million.)

Proposed Termination of Alternate Engine Program

The administration's proposed FY2010 budget proposes terminating the F-35 alternate engine program.

Issues For Congress

Alternate Engine

A key issue for Congress for the F-35 program in FY2010 is the administration's proposal to terminate the F-35 alternate engine program, which is intended to develop the General Electric/Rolls-Royce F136 engine as an alternative to the Pratt and Whitney F135 engine that currently powers the F-35. As mentioned earlier, the George W. Bush administration proposed terminating the alternate engine program in FY2007, FY2008, and FY2009, but Congress rejected these proposals and each year provided funding for the program's continuation.

Summary of Arguments For and Against Termination

Supporters of the administration's proposal to terminate the alternate engine program argue the following:

- Development, testing, and production of the F135 have reached the point where it is no longer necessary to hedge against the possibility of technical problems in

the F135 engine by pursuing an alternate engine program as a backup. The causes of F135 test failures in 2007 and 2008 have been identified and fixes are being implemented.

- Developing and procuring a second engine for the F-35 would add billions of dollars to the cost of the F-35 program by doubling engine development costs and halving engine production economies of scale, reducing the number of F-35s that could be procured within a given total amount of F-35 acquisition funding.
- Procuring a second engine for the F-35 would increase F-35 life-cycle operation and support (O&S) costs by requiring DOD to maintain two F-35 engine maintenance and repair pipelines.

Opponents of the administration's proposal to terminate the alternate engine program argue the following:

- Given that F-35s in the future are to constitute the vast majority of the country's strike fighters, and in light of F135 test failures in 2007 and 2008, it would be imprudent to have all those strike fighters powered by a single type of engine, since a problem with that engine could force the grounding of the entire F-35 fleet.
- Having a second engine in production (or ready for production) would permit DOD to use competition (or the threat of competition) in procuring and supporting F-35 engines, which will reduce F-35 engine procurement and O&S costs compared to what would be achievable in a sole-source procurement, offsetting the additional costs associated with developing, procuring, and supporting a second engine. Competition (or the threat of competition) would also promote better engine performance, increased engine reliability, and improved contractor responsiveness.
- Having two F-35 production lines in operation would permit F-35 engine production to quickly surge to higher levels if needed to respond to a change in the strategic environment, and preserve a potential for maintaining effective competition in the development and procurement of future tactical aircraft engines, particularly if F-22 and F/A-18E/F production ends.

Administration Perspective

An Office of Management and Budget (OMB) document on proposed FY2010 program terminations, reductions, and savings states that:

The Administration has decided not to fund the Joint Strike Fighter (JSF) Alternative Engine Program (AEP), because it is no longer needed as a hedge against the failure of the main Joint Strike Fighter engine program. The Department of Defense (DOD) proposed cancelling the JSF AEP in the President's 2007 Budget because development of the main engine was progressing well and analysis indicated that savings from competition would not be offset by high upfront costs. DOD did not request funding for the program in the 2008 and 2009 Budgets. However, the Congress has rejected the proposed cancellations and has added funding each year since 2007 to sustain the AEP development....

Because DOD wanted to reduce technical risk in the development of the JSF engine, the Department has had two contractors developing separate JSF engines. However, in 2007,

DOD proposed to cancel the contract for the second (alternate) engine because the main engine program was progressing well, making a second engine program unnecessary. Moreover, financial benefits, such as savings from competition, have been assessed to be small, if they exist at all, because of the high cost of developing, producing and maintaining a second engine. The reasons for canceling the AEP in 2007 remain valid today. Studies by both the Government Accountability Office and Congressional Budget Office have questioned the affordability of the current defense program, particularly the high cost of modernizing tactical aviation.³⁵ Canceling the AEP will result in estimated near-term savings of over a billion dollars.³⁶

At a May 20, 2009, hearing before the Air and Land Forces subcommittee of the House Armed Services Committee on Air Force acquisition programs, a DOD acquisition official stated:

The F-35 acquisition strategy contains provisions for a competitive engine program, provided funds are available to execute that strategy. Currently, the F135 engine is completing the development phase and beginning initial low rate production to support the F-35 aircraft production and test schedule. The F135 experienced two separate low pressure turbine blade failures, the first in the September 2007 and the second in February 2008. Root cause analysis determined the problem. The appropriate fixes were identified and are being incorporated into the remaining test and all future production engines. The engines were certified for Short Take-Off and Vertical Landing testing in January 2009, and the program recently completed hover pit testing as it prepares for full vertical landing flight tests later this year.

The Department did not include funding in the Fiscal Year 2010 President's Budget for the F136 competitive engine. The decision to not include funding for the F136 is consistent with the Department's position on this issue for the prior three budget submissions. The decision this year was reviewed by the Department's leadership as well as the Administration. The determination of whether to fund the competitive engine, as it has in the past, was weighed against the budget priorities of the Department as a whole, the optimum use of taxpayer's dollars in executing and preparing for the National defense, and the benefits to the F-35 program. The Department continues to execute appropriated development funding to ensure that a competitive engine program remains viable while there is funding is available. Since there is no follow-on procurement funding in Fiscal Year 2010, the Department has delayed execution of advance procurement funding appropriated in the Fiscal Year 2009 Appropriations Act. The Department's policy is to execute advance procurement funds only when associated follow-on procurement funding or a programmed plan that contains full procurement funding is available.³⁷

At the same hearing, Air Force officials stated the following:

Presidential Budget 10, released earlier this month, cancelled the alternate engine program for the Joint Strike Fighter, and removed all further funding for the development and

³⁵ The passage at this point has a footnote citing the following two reports: Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-09-326SP, March 2009; and Congressional Budget Office, *Long Term Implications of the Fiscal Year 2009 Future Years Defense Program*, January 2009.

³⁶ Office of Management and Budget. *Terminations, Reductions, and Savings, Budget of the U.S. Government, Fiscal Year, 2010*. Washington, May 2009. p. 38.

³⁷ Statement of Mr. David G. Ahern, Director, Portfolio Systems Acquisition, Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics), Before the House Armed Services Committee Subcommittee on Air and Land Forces, May 20, 2009, pp. 6-7.

procurement of this second engine. The Air Force and Navy are executing the funding appropriated by Congress in the 2009 budget to continue the F136 program.

The cost to continue F136 engine development is approximately \$1.8B through FY15. In addition, the Department of Defense will have to fund the production of GE engines to get the suppliers on equal footing in the amount of approximately \$2.8B. Continued funding for the F136 engine carries cost penalties to both F135 and F136 engines for reduced production line learning curves and inefficient economic order quantities. The department has concluded that maintaining a single engine supplier provides the best balance of cost and risk. Our belief is the risks associated with a single source engine supplier are manageable due to improvements in engine technology and do not outweigh the investment required to fund a competitive alternate engine.³⁸

GAO Perspective

At a May 20, 2009, hearing before the Air and Land Forces subcommittee of the House Armed Services Committee on Air Force acquisition programs, GAO testified on the F-35 program, stating in the testimony's summary that:

The department [i.e., DOD] has not asked for funding for the alternate engine program in the budgets since 2007 arguing that an alternate engine is not needed as a hedge against the failure of the main engine program and that the savings from competition would be small. Nonetheless, the Congress has added funding each year since then to sustain its development. Our prior analysis indicates that competitive pressures could yield enough savings to offset the costs of competition over the JSF program's life. To date, the two contractors have spent over \$8 billion on engine development—over \$6 billion with the main engine contractor and over \$2 billion with the second source contractor.³⁹

Elaborating on this summary statement, the testimony stated the following:

DOD's Proposal to Cancel the Alternate Engine Program May Bypass Long-term Merits

DOD and the Congress have had a continuing debate for several years on the merits of an alternate engine program to provide a second source and competition for engine procurement and life cycle support. The alternate engine program was part of the original JSF acquisition strategy. The department first proposed canceling the alternate engine program in the 2007 budget and has not asked for funding in the budgets since then. The administration does not believe an alternate engine is needed as a hedge against the failure of the main engine program and believes savings from competition would be small. The Congress has added funding each year since 2007 to sustain the alternate engine development, including \$465 million for fiscal year 2009. To date, the two contractors have spent over \$8 billion on

³⁸ Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5) [and] Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ) Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8) May 20, 2009, p. 11.

³⁹ Government Accountability Office, *Joint Strike Fighter[:]: Strong Risk Management Essential as Program Enters Most Challenging Phase*, Statement of Michael Sullivan, Director Acquisition and Sourcing Management. GAO-09-711T, May 20, 2009, summary page.

engines development—over \$6 billion with the main engine contractor and over \$2 billion with the second source contractor.

The way forward for the JSF engine acquisition strategy entails one of many critical choices facing DOD today, and underscores the importance of decisions facing the program. As we noted in past testimonies before this committee, the acquisition strategy for the JSF engine must weigh expected costs against potential rewards. In each of the past 2 years we have testified before this committee on the merits of a competitive engine program for the Joint Strike Fighter.⁴⁰ While we did not update our analysis we believe it is still relevant and the same conclusions can be drawn. We reported in 2008 that to continue the JSF alternate engine program, an additional investment of about \$3.5 billion to \$4.5 billion in development and production-related costs, may be required to ensure competition.⁴¹ Our earlier cost analysis suggests that a savings of 9 to 11 percent would recoup that investment. As we reported last year, a competitive strategy has the potential for savings equal to or exceeding that amount across the life cycle of the engine. Prior experience indicates that it is reasonable to assume that competition on the JSF engine program could yield savings of at least that much. As a result, we remain confident that competitive pressures could yield enough savings to offset the costs of competition over the JSF program's life. However, we recognize that this ultimately will depend on the final approach for the competition, the number of aircraft actually purchased, and the ratio of engines awarded to each contractor.

Results from past competitions provide evidence of potential financial and nonfinancial savings that can be derived from engine programs. One relevant case study to consider is the “Great Engine War” of the 1980s—the competition between Pratt & Whitney and General Electric to supply military engines for the F-16 and other fighter aircraft programs. At that time, all engines for the F-14 and F-15 aircraft were being produced on a sole-source basis by Pratt & Whitney, which was criticized for increased procurement and maintenance costs, along with a general lack of responsiveness to government concerns about those programs. For example, safety issues with the single-engine F-16 aircraft were seen as having greater consequences than safety issues with the twin-engine F-14 or F-15 aircraft. To address concerns, the Air Force began to fund the development and testing of an alternate engine to be produced by General Electric; the Air Force also supported the advent of an improved derivative of the Pratt & Whitney engine. Beginning in 1983, the Air Force initiated a competition that Air Force documentation suggests resulted in significant cost savings in the program. In the first 4 years of the competition, when actual costs are compared to the program's baseline estimate, results included (1) nearly 30 percent cumulative savings for acquisition costs, (2) roughly 16 percent cumulative savings for operations and support costs; and (3) total savings of about 21 percent in overall life cycle costs.

The Great Engine War was able to generate significant benefits because competition incentivized contractors to improve designs and reduce costs during production and sustainment. Competitive pressure continues today as the F-15 and F-16 aircraft are still being sold internationally. While other defense competitions resulted in some level of

⁴⁰ The passage at this point has a footnote citing the following two prior instances of GAO testimony: Government Accountability Office, *Joint Strike Fighter[.] Impact of Recent Decisions on Program Risks*, Statement of Michael Sullivan, Director Acquisition and Sourcing Management, Testimony before the Subcommittees on Air and Land Forces, and Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives, GAO-08-569T, March 11, 2008; and Government Accountability Office, *Defense Acquisitions[.] Analysis of Costs for the Joint Strike Fighter Engine Program*, Statement of Michael Sullivan, Director Acquisition and Sourcing Management, Testimony before the Subcommittees on Air and Land Forces, and Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives, GAO-07-656T, March 22, 2007.

⁴¹ The passage at this point has a footnote stating: “Since that time, Congress appropriated \$465 million in the fiscal year 2009 budget to continue the alternate engine program.”

benefits, especially with regard to contractor responsiveness, they did not see the same levels of success absent continued competitive pressures.

Similar competition for the JSF engines may also provide benefits that do not result in immediate financial savings, but could result in reduced costs or other positive outcomes over time. Our prior work, along with studies by DOD and others, indicate there are a number of nonfinancial benefits that may result from competition, including better performance, increased reliability, and improved contractor responsiveness. In addition, the long-term effects of the JSF engine program on the global industrial base go far beyond the two competing contractors.

DOD and others have performed studies and have widespread concurrence as to these other benefits, including better engine performance, increased reliability, and improved contractor responsiveness. In fact, in 1998 and 2002, DOD program management advisory groups assessed the JSF alternate engine program and found the potential for significant benefits in these and other areas. Table 2 summarizes the benefits determined by those groups.

Table 2: 1998 and 2002 Program Management Advisory Group Study Findings on the Benefits of an Alternate Engine Program

Factor assessed	Beneficial		Marginal		No Value	
	1998	2002	1998	2002	1998	2002
Costs			X	X		
Development risk reduction					X	X
Engine growth potential			X	X		
Fleet readiness	X	X				
Industrial base	X	X				
Int'l implications	X	X				
Other considerations ^d	X	X				
Overall	X	X				

Source: GAO analysis of DOD data.

- d. Other considerations include contractor responsiveness, improved design solutions, and competition at the engine subsystem level.

While the benefits highlighted may be more difficult to quantify, they are no less important, and ultimately were strongly considered in recommending continuation of the alternate engine program. These studies concluded that the program would maintain the industrial base for fighter engine technology, enhance readiness, instill contractor incentives for better performance, ensure an operational alternative if the current engine developed problems, and enhance international participation.

Another potential benefit of having an alternate engine program, and one also supported by the program advisory groups, is to reduce the risk that a single point systemic failure in the engine design could substantially affect the fighter aircraft fleet. This point is underscored by recent failures of the Pratt & Whitney test program. In August 2007, an engine running at a test facility experienced failures in the low pressure turbine blade and bearing, which

resulted in a suspension of all engine test activity. In February 2008, during follow-on testing to prove the root cause of these failures, a blade failure occurred in another engine, resulting in delays to both the Air Force and Marine Corps variant flight test programs.⁴²

Press Reports

A June 1, 2009, press report states:

Funding development of a second engine from within the existing F-35 budget would cut production by dozens of aircraft and push up program costs, the Joint Strike Fighter's program chief warns in an interview with Aviation Week.

The concerns come as Congress is expected to reverse the White House and Pentagon's effort to cancel the alternate powerplant.

Forcing the program to fund development of the General Electric/Rolls-Royce F136 from within the existing JSF budget would "take 50-80 tails out of the program" over the next five years, says the program executive officer (PEO), Marine Corps Brig. Gen. David Heinz.

The Defense Department's fiscal 2010 budget request calls for procurement of 513 F-35s over five years, an increase of 25 over previous plans, with another 180 expected to be built for international partners over the same period. This would take annual production "into the low 200s" by FY '15, he says.

Funding the F136 within the existing budget would require cutting six aircraft from the 30 planned in FY '10, Heinz says. This would make aircraft in subsequent years more expensive, pushing back international purchases and compounding the problem because the partners could not afford early aircraft, he says.

"We would never get to 200 tails [a year]. We would build out to around 100, under-utilize the tooling and not get down the learning curve," the PEO says. "I worry about taking tails out of the program because it will get so expensive the partners will start to pull back."

Pentagon leadership has not sought to continue the F136, arguing DOD can only afford the Pratt & Whitney F135 primary engine. But Congress is expected to reinstate the funding. Lawmakers, with widespread consensus, have ignored the cancellation effort for years and earmarked money for the alternate.

But before, some of the restored funding has come from within the existing JSF budget, forcing cuts elsewhere in the program. Former U.S. Air Force leaders have testified on Capitol Hill that they didn't so much oppose an alternate engine as they did sacrificing elsewhere to fund it (Aerospace DAILY, March 7, 2008).

The GE/R-R Fighter Engine Team has defended its lobbying for the F136. "We've never advocated taking the money out of the other parts of the program. Congress needs to decide where the money comes from," says Dennis Jarvi, president of Rolls-Royce North America Defense.

⁴² Government Accountability Office, *Joint Strike Fighter[:]: Strong Risk Management Essential as Program Enters Most Challenging Phase*, Statement of Michael Sullivan, Director Acquisition and Sourcing Management. GAO-09-711T, May 20, 2009, pp. 4-7.

The international partners would like a competing engine, and Pentagon efforts to kill the F136 are “sure to be a major topic” when they meet in Washington later this month, says Tom Burbage, Lockheed executive vice-president and general manager, F-35 program integration. “There is support in the international community for the second engine,” he tells Aviation Week.

Burbage says the second-engine issue is “programmatically complex” because, while Congress has incrementally funded development of the F136, the Defense Dept. has not factored production of two engines into its budget planning and not decided how it would conduct an annual leader/follower competition.

“It’s the clear intent of Congress to have a second engine, but it could have a very substantial impact,” he says.⁴³

A June 3, 2009, press report states:

The top Joint Strike Fighter official says he unequivocally supports President Barack Obama’s fiscal 2010 budget request, which does not seek funds for a second JSF engine—but he is still planning for the F136 and suggests Washington consider the risk otherwise.

Citing the potential for “competitive advantage” from alternate engines for the single-engine F-35, and noting that there could be an operational risk some day from having just one engine, Marine Corps Brig. Gen. David Heinz told reporters at the JSF Joint Program Office June 2 that there might be considerations beyond the financial cost of funding dual powerplant efforts.

“Do we still believe that’s acceptable?” Heinz asked rhetorically.

Meantime, the general—selected for his second star after his promotion from deputy program chief—says it would be irresponsible for him not to plan for both engine efforts. “I have to,” he asserts, adding it would be “downright reckless” not to after Congress has earmarked funds for the second engine several times already. And besides, military officials spend a lot of their time planning for things that do not happen, he joked.

Heinz explained to the roundtable of reporters that funding development of a second engine from within the existing F-35 budget would cut production by 50 or more aircraft and push up program costs—a point he made to Aviation Week last week (*Aerospace DAILY*, May 29). But the program executive officer also stressed that economic modeling was difficult, and that a competition for the engines would likely drive down costs.

Heinz further asserted that the primary Pratt & Whitney F135 engine has yet to truly compete with the General Electric/Rolls-Royce F136, regardless of what Pratt and some supporters may suggest.

Assuming the program’s planned ramp-up and a 50-50 split engine order during the sixth low-rate initial production tranche, fiscal 2013 would be the first genuine year of the rivalry. Such a race could bring technology advancements too, the general notes. “They are just beginning in that competition,” he says.

⁴³ Graham Warwick and Guy Norris, “Second Engine Could Force F-35 Production Cuts, PEO Warns,” *Aerospace Daily & Defense Report*, June 1, 2009: 3.

Elsewhere, Heinz said authorities are trying to track down and prosecute those responsible for a cyber breach of the program a few years ago, recently highlighted in news reports. He would not comment further, saying all the publicity does not necessarily help that effort. “We are trying to actually capture a few of these individuals,” he says.⁴⁴

A June 8, 2009, press report states:

The new general in charge of the F-35 Joint Strike Fighter program last week told reporters the Defense Department must weigh the operational risks of having a single engine program for the fifth-generation jet rather than solely looking at the cost implications of procuring two power plants.

The F-35 Lightning II was conceived to be developed with two engines, the Pratt & Whitney F135 and the General Electric-Rolls-Royce F136. However, DOD in recent years—including in its budget request for fiscal year 2010—has zeroed funding for the second power plant.

Each year, Congress has reintroduced full funding for the F136 in its markups of the defense budget. “I support the president’s budget, but in the future, should there be an engine incident on the F135 motor, our ability to absorb an incident that may ground a large number of those motors ... is going to lessen,” Marine Corps Brig. Gen. David Heinz said during a June 2 briefing at the JSF program office in Arlington, VA, noting that the F-35 will eventually replace a number of legacy jets, including the F-15 Eagle, the F-16 Viper, the F/A-18 Hornet and the AV-8B Harrier II.

As such, the military will not have the operational flexibility it has today if an engine problem leads to the grounding of the F-35 fleet with a single engine, Heinz added.

“I believe part of the debate that has to occur and is occurring is, ‘Is there an operational risk that we are accepting by having just one engine manufactured?’” he said. “I simply think we focus too much on the discussion about cost benefit and not operational risk benefit.”

Heinz also continued the rhetoric of his predecessor—Air Force Maj. Gen. Charles Davis—that the true cost savings of having two engines competing in the program have yet to be revealed. In the 1980s engine wars, per-unit costs reductions reached 20 percent due to competition, he noted.

“I think that, because of the difference in the development time line, that [the competition] has not yet occurred,” the Marine Corps one-star said. “Pratt is not truly competing with GE yet for the market share, because I only have Pratt engines through [low-rate initial production]-3. We’re going to introduce—if Congress fully funds in the [fiscal year 2010] budget—four GE motors, but that’s four out of 30 motors that we’ll buy next year, so they’re just beginning in that competition. I do not believe yet that Pratt feels compelled as though they are in competition with GE.”

DOD last week awarded JSF prime contractor Lockheed Martin a \$2 billion contract to produce 17 LRIP-3 F-35s. The lot includes the first international orders—two operational test aircraft for the United Kingdom and one for the Netherlands. In March and April, Lockheed received \$306 million to prepare production for 32 LRIP-4 aircraft. When the competition truly heats up between Pratt and the GE-Rolls-Royce Fighter Engine team, Heinz said there will be “much more technology push” between the two, because they will

⁴⁴ Michael Bruno, “JSF Program Chief Cites Advantages Of Competing Engines,” *Aerospace Daily & Defense Report*, June 3, 2009: 1-2.

be striving to win more engine buys. The two companies also will try to introduce such innovations as more efficient blades, fuel savings and thrust growth capability.

Late last month, team officials told reporters there is a “strong business case” to continue the second engine program, and it will cost roughly \$130 million—compared to the \$100 billion total for F-35 engine production—to open the F136 production line.

Further, international partners including the United Kingdom entered into the JSF program with the expectation that there will be two engines, they contended. If Congress directs the JSF program office to continue the F136 program, then Heinz will introduce the first four GE-Rolls-Royce power plants into the F-35’s fourth low-rate initial production lot, the Marine Corps general said. The engine buys will then ramp up to the point where there will be a 50-50 split in engine procurement by LRIP-6.

“That would also allow the GE motor to be in operation for about a year in the fleet so I now have both costing data, I’ve got them to about the same point in quantities, and I’ve got operational experience with both motors,” Heinz said. “At that point, the services and the [Joint Program Office] have pretty good information to start competition and to start the competitive nature to start to drive how much quantity I buy in the next years following that.”

The true competition, by Heinz’s calculations, will begin in FY-13, he said.

Adding that it would be “reckless” not to plan for the possibility of F136 congressional funding, Heinz said the Office of the Secretary of Defense should release advance procurement funding for the second engine if Congress shows their commitment to the program in its markup of the FY-10 budget. Though such funding has been appropriated in previous years’ budgets, none of the money thus far has gone to the program office.⁴⁵

A June 18, 2009, press report states:

Despite the Obama administration’s official desire to cancel the General Electric/Rolls-Royce (GE/RR) F136 alternate engine for the F-35 Joint Strike Fighter, the program and its customers are privately telling the manufacturers that the engine is needed.

Behind this apparent contradiction, GE and RR people at the show here believe, is the fact that the F136 has more inherent power potential than the current Pratt & Whitney F135 configuration.

GE program leader Jean Lydon-Rogers confirmed here, for the first time in a formal briefing, that the F136 was designed, from the start of system development and demonstration in 2004, with a bigger core and greater total airflow than was planned in the pre-SDD stage, to deal with increases in the JSF’s weight.

One result is that the engine could gain 5 percent in thrust (more than 2,000 pounds) with a simple software change. In the medium term, though, GE and RR believe that the F136 has a bigger temperature margin than the F135, allowing it to maintain performance in hot-and-high conditions.

⁴⁵ Jason Simpson, “Heinz: DOD Must Look At Operational Risks of Having One JSF Engine,” *Inside the Navy*, June 8, 2009.

This will be important for the United Kingdom. Although the F135 is expected to meet formal key performance parameters, including the short-takeoff-and-vertical-landing F-35B's bring-back requirement for the U.S. Marine Corps, Britain's experience of Harrier operations under hot, humid and high-level conditions in Afghanistan has led to a tougher "hot day" definition. GE and RR say that the F136 can deliver more performance under those conditions.

The program office and customers recognize this issue, according to people associated with the F136. The problem is that in the past (and still, with this week's action in the House of Representatives), Congress has cut aircraft from the program to pay for the F136 (*Aerospace Daily*, June 17), and the program office and customers don't want to see that happen either. They want Congress to fund the F136 from other sources. Further complicating the issue is that the White House has now formally come out in favor of cutting the F136.⁴⁶

Development Status and Readiness for Higher-Rate Production

Another issue for Congress for the F-35 program in FY2010 concerns the development status of the F-35 and whether the aircraft is ready to shift into higher rate production.

Administration Perspective

At a May 20, 2009, hearing before the Air and Land Forces subcommittee of the House Armed Services Committee on Air Force acquisition programs, a DOD acquisition official stated:

The decision to increase the six-year F-35 production profile by 28 aircraft was driven by the need to create a more efficient ramp-rate from year to year as we prepare to enter full-rate production in the 2015 timeframe. Accelerating the 28 aircraft deliveries into the Fiscal Years 2010-2015 FYDP lowers the unit cost, expedites delivery of aircraft to the warfighter, and has the added benefit of saving approximately \$500 million over the life of the program. More importantly, appropriately managing the investments in this ramp-rate is critical to meeting our warfighter requirements at the lowest possible cost to the taxpayer. The current state of the flight test schedule was considered in making this decision. The developmental flight testing begins in earnest this year, with operational testing not scheduled to begin until 2012. While flight testing is an important part of the program, it is not the only indicator of performance verification. Design maturity, manufacturing quality metrics, and software stability are providing confidence through initial structural testing, limited flight envelope testing, and predicted versus actual performance in the large number of labs and simulators. The Department believes that the investment now, to achieve a more efficient production ramp, will yield savings over the long term and ensure the Services receive the warfighting assets they need to execute their operational requirements.⁴⁷

At the same hearing, Air Force officials stated the following:

The F-35 is projected to meet all Key Performance Parameters (KPP) and as of 10 May 2009, AA-1 [an F-35 SDD aircraft] has completed 84 test flights, including a deployment to Eglin AFB. The first system design and development (SDD) Short Take-Off and Vertical

⁴⁶ Bill Sweetman, "JSF Needs F136, Partners Say At Air Show," *Aerospace Daily & Defense Report*, June 18, 2009: 2.

⁴⁷ Statement of Mr. David G. Ahern, Director, Portfolio Systems Acquisition, Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics), Before the House Armed Services Committee Subcommittee on Air and Land Forces, May 20, 2009, p. 7.

Landing (STOVL) aircraft, BF-1, has completed 14 flights. The second SDD STOVL aircraft, BF-2, had its first flight in February 2009. The Cooperative Avionics Test Bed (CAT-B) continues to provide unprecedented risk reduction at this stage in a major weapon system not seen in any legacy program. In December 2008, the Defense Acquisition Executive (DAE) approved full funding for 7 Conventional Take-Off and Landing (CTOL) aircraft and engines, plus sustainment and associated equipment as part of the Low Rate Initial Production (LRIP) Lot 3 acquisition decision memorandum. In addition, the DAE approved full funding for seven STOVL aircraft plus sustainment and associated equipment contingent upon successful completion of the F135 Pratt & Whitney lead engine Stress Test, Flight Test Engine 6 Proof Test and receipt of full STOVL flight clearance, which occurred on 30 January 2009.⁴⁸

At a May 19, 2009, hearing before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee on Department of the Navy aviation procurement programs, Navy and Marine Corps Officials stated:

Three SDD jets (AA-1, BF-1 and BF-2) are in flight testing. The remaining SDD jets and ground test articles, plus Low Rate Initial Production (LRIP) I and LRIP II aircraft, are in various stages of production. The SDD jets are setting new standards for quality and manufacturing efficiencies that improve with each jet. In flight testing, the initial Conventional Takeoff and Landing (CTOL) aircraft (AA-1) has demonstrated superb performance and reduced program risk, with 81 sorties (~111 flight hours) flown through April 20, 2009. BF-1, the first STOVL flight test jet, first flew in June 2008, on the schedule established two-years prior. BF-1 has flown 14 flights (~13 hours), and is currently on the hover pit, undergoing vertical engine operations. BF-2 first flew February 2009 and returned with no flight discrepancies noted. BG-1 static test results are favorable. The F135 engine has completed 11,300+ test hours on 16 engines through mid-April 2009. Software is 74% complete, with 13 million lines of code released including Block 0.5 Mission Systems, per the spiral development plan/schedule and with record-setting code-writing efficiencies. Software demonstrates stability across multiple Mission System subsystems.

Systems integration testing continues on plan via flight tests, a flying lab and over 150,000 hours of ground labs testing. A fully integrated Mission Systems jet will fly later this year. The second production lot contract was signed below the cost model prediction. LRIP III contract negotiations are near complete, and LRIP IV Advance Procurement funding is on contract. All F-35 variants are projected to meet their respective Key Performance Parameters. The F-35 plan for incremental blocks of capability balances cost, schedule and risk.⁴⁹

⁴⁸ Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5) [and] Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ) Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8) May 20, 2009, pp. 10-11.

⁴⁹ Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, Before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy's Aviation Procurement Program, May 19, 2009, p. 2.

GAO Perspective

March 2009 GAO Report

A March 2009 Government Accountability Office (GAO) report providing assessments of major DOD weapon acquisition programs stated the following about the F-35 program:

Technology Maturity

Five of the JSF's eight critical technologies are mature. The remaining three—mission systems integration, prognostics and health management, the radar—are approaching maturity.

Design Maturity

The program reported that it had released over 90 percent of planned engineering drawings for each of the three variants indicating that the designs are generally stable. While the designs appear stable, the late release of design drawings led to manufacturing inefficiencies from which the program is still recovering.

Production Maturity

The JSF program's production processes are not mature. While the program collects information on the maturity of manufacturing processes, a good practice, only about 12 percent of its critical manufacturing processes are in statistical control. Projected labor hours have increased about 40 percent since 2007. The late release of drawings and subsequent supplier problems have led to late part deliveries, delaying the program schedule and forcing inefficient manufacturing processes. Program officials do not expect these inefficiencies to be fully corrected until 2010, during its third low rate production lot.

The JSF designs are still not fully proven and tested. Flight testing, begun in late 2006, was only about two percent completed as of November 2008. The program began testing its first production representative prototype—a short takeoff vertical landing variant flown in conventional mode—in June 2008. A fully integrated, capable aircraft is not expected to enter flight testing until 2012, increasing risks that problems found may require design and production changes and retrofits of completed aircraft.

Other Program Issues

The program continues to experience significant cost increases and schedule delays. A recent independent cost estimate identified additional funding requirements for system development of as much as \$7.44 billion through fiscal year 2016. This would increase the total development costs 14 percent from \$44.3 billion to \$51.81 billion. The estimating team also projected a three year extension in system development. Separately, the program office has projected that development costs will increase by approximately \$2.43 billion to address cost overruns on the airframe and engine contracts and to pay for a one-year schedule extension. The independent cost estimate was higher than the program office estimate because it also included (1) the alternate engine effort, (2) higher contractor engineering staff levels, (3) additional software growth, (4) an expanded flight test program, and (5) more labor hours to manufacture aircraft. Program officials argue that costs will be lower than the independent estimate because, among other things, they believe the program has made substantial progress in software development and has invested heavily in advanced simulation labs intended to reduce risk.

Despite the program's continued manufacturing problems and the infancy of the flight test program, DOD officials want to accelerate production by 169 aircraft between fiscal years 2010 and 2015. This may require up to \$33.5 billion in additional procurement funding in those years. We believe this more aggressive production approach is optimistic and risky.

Program Office Comments

The program noted that JSF's technical, software, production processes, and testing maturity are tracking to plan and substantially exceeding standards set in past programs. The manufacturing fit and quality of the jets are unprecedented and production processes are improving with each jet. The program's second prototype test aircraft flew on the schedule established two-years prior. Software development is 65 percent complete (twelve million lines) in accordance with the spiral development plan/schedule and with record-setting code-writing efficiencies. The software demonstrates stability across multiple mission system subsystems. Systems integration testing continues on schedule through the use of flight tests, a flying lab, and over 150,000 hours of ground labs testing. A fully integrated mission systems jet is scheduled to fly in 2009. The latest DOD independent cost estimate increased little from the one of four years ago. The second production lot contract was signed for a price below the cost model prediction. The program's plan for incremental blocks of capability balances cost, schedule and risk.⁵⁰

May 2009 GAO Testimony

At a May 20, 2009, hearing before the Air and Land Forces subcommittee of the House Armed Services Committee on Air Force acquisition programs, GAO testified on the F-35 program, stating:

JSF development will cost more and take longer to complete than reported to the Congress in April 2008, primarily because of contract cost overruns and extended time needed to complete flight testing. DOD is also significantly increasing annual procurement rates and plans to buy some aircraft sooner than reported last year. Total development costs are projected to increase between \$2.4 billion and \$7.4 billion and the schedule for completing system development extended from 1 to 3 years....

Manufacturing of development test aircraft is taking more time, money, and effort than planned, but officials believe that they can still deliver the 9 remaining test aircraft by early 2010. The contractor has not yet demonstrated mature manufacturing processes, or an ability to produce at currently planned rates. It has taken steps to improve manufacturing; however, given the manufacturing challenges, DOD's plan to increase procurement in the near term adds considerable risk and will be difficult to achieve.

DOD is procuring a substantial number of JSF aircraft using cost reimbursement contracts. Cost reimbursement contracts place most of the risk on the buyer—DOD in this case—who is liable to pay more than budgeted should labor, material, or other incurred costs be more than expected when the contract was signed.

JSF flight testing is still in its infancy and continues to experience flight testing delays. Nonetheless, DOD is making substantial investments before flight testing proves that the JSF

⁵⁰ Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*. GAO-09-326SP, March 2009. p. 94.

will perform as expected. DOD may procure 273 aircraft costing an estimated \$42 billion before completing flight testing.

Procurement Investments and Progress of Flight Testing

	2007	2008	2009	2010	2011	2012	2013	2014
Cumulative procurement (billions of dollars)	\$0.9	\$3.6	\$6.9	\$13.7	\$20.6	\$31.1	\$41.9	\$54.3
Cumulative aircraft procured	2	14	28	58	101	183	273	383
Percentage of flight test program completed	<1%	<1%	2%	9%	34%	62%	88%	100%

Source: GAO analysis of DOD data⁵¹

Press Reports

A June 2, 2009, press report states:

Joint Strike Fighter officials are refocusing the program on delivering test-ready aircraft following further delays to completing F-35s for development flight-testing.

The shift will delay the first flight of aircraft still in production by up to three months, but is expected to enable faster flight-testing to recover some of the slippage.

Aircraft were previously being flown once, then grounded for modifications to incorporate design changes resulting from analysis and testing.

“There was a lot of emphasis on first flight under past program leadership. The event became important, not the readiness [for testing],” says Doug Pearson, vice president of the F-35 integrated task force.

“When there was more work to do on the aircraft, it was added after first flight. And over time, the additions became more than we wished for,” he says. For example, aircraft BF-2 flew once in February and has been in modification since.

New JSF program executive officer Brig. Gen. David Heinz has asked Lockheed Martin to study the effect of rephrasing the work to accomplish the modifications on assembly before first flight.

The ferry flight to the test center at Edwards Air Force Base in California or Naval Air Station Patuxent River in Maryland would become the new programmatic milestone. “We need to get them built, and ready to test, before they fly,” Pearson says.

⁵¹ Government Accountability Office, *Joint Strike Fighter[:]: Strong Risk Management Essential as Program Enters Most Challenging Phase*, Statement of Michael Sullivan, Director Acquisition and Sourcing Management. GAO-09-711T, May 20, 2009, summary page.

Instead of flying all the development F-35s by year's end, four of the aircraft would slip into 2010, Heinz says, but Lockheed hopes to recover some of the delay by delivering fully modified aircraft into productive flight-testing.

Aircraft BF-1, the first short takeoff and vertical landing (STOVL) F-35B, is in modification following hover-pit testing and is expected to return to flight by the end of July.

After around 12 flights from the Fort Worth, Texas, plant to verify design changes and qualify the aircraft for probe-and-drogue refueling, BF-1 is expected to ferry to Patuxent River at the end of August to begin STOVL "build down" flight-testing.

Another 12-20 flights at progressively lower altitudes and speeds are expected to culminate in the first vertical land on the hover pad at Patuxent River in September/October.

"I will be surprised if it goes beyond October," says Pearson, while describing it as an aggressive schedule. "There's a reasonable chance it will happen before the end of September."

Aircraft BF-2 is due at Patuxent River in September while BF-4, the first F-35 mission-system test aircraft, is expected to arrive by year's end. BF-3 is a loads aircraft and will go through extensive ground testing before flying.

Aircraft AF-1 and -2, the first production-representative conventional takeoff and landing F-35As, will be the next aircraft to fly, Pearson says. They are scheduled for delivery to the Edwards test center in the first quarter of next year.

The first F-35C carrier variant, CF-1, is now scheduled to fly on Dec. 23, a slip of three months, with the other two test aircraft following early in 2010. All three will go to Patuxent River.

Because of delays, the bulk of the 5,000-plus development flights will now be conducted in 2010 and 2011, but Pearson still expects to complete operational testing in 2014. The original schedule was 2013, but this was extended last year.⁵²

A June 8, 2009, press report states:

The Marine Corps short-take-off, vertical-landing (STOVL) variant of the Joint Strike Fighter is now slated to begin in-flight transition to the aircraft's lift fan in August, months later than originally intended, Brig. Gen. David Heinz, JSF program executive officer, said last week.

There are still tests and modifications that need to be done on the first STOVL test aircraft, BF-1, before the ramp-down to full vertical flight can begin, Heinz said, adding that the delay to the aircraft would not have a significant impact on the testing schedule because the program has a cushion built in to absorb such setbacks. The tests were originally supposed to take place this spring.

"Today I have programmed for the availability slots a ramp to get to 12 successful sorties per month per airplane," he said during a June 2 roundtable with reporters at the JSF program office in Arlington, VA. "If you take in aggregate every one of those airplanes sliding three

⁵² Graham Warwick, "JSF Program Refocusing On Test-Ready Aircraft Deliveries," *Aerospace Daily & Defense Report*, June 2, 2009: 1-2. Material in brackets as in original.

months before you deliver them to the flight test program, that only goes to 12.6 successful sorties.”

Heinz noted that it is a three-year test program and, at the end of this year, all 12 of the flight test vehicles for the Navy, Marine Corps and Air Force JSF variants will have been delivered. He said the program has already resourced for six flying days per week while his schedule calls for using only five.

“First of all, 12.6 is really in the national average,” he said. “The F/A-18E/F program accomplished about 13.1 ... so I’m not asking this huge leap.”

As it stands now, the BF-1 finished hover-pit testing and is undergoing modifications, which will end this month. The plane will begin a series of 12 flights transition from conventional flight to STOVL mode at the end of August, leading to its first full vertical landing about a month later, the general said.

Heinz said he is not worried about the Pratt and Whitney-built F135 engine, which had high-cycle fatigue problems in the past year.

“I’m not at all concerned about that,” he said. “We’ve already done all the durability testing that proves out that that’s going to work for the life of the motor.”

Heinz also pointed to the reliability of the aircraft and the software, which he claimed were performing very well.

“I’m already achieving on the order of 80 flight hours before a software incident,” he said.

The program has also conducted 99 flights, and “77 of those flights have come back ready to fly the mission without work, and so that is a good indicator,” he said.

In all, the three JSF variants will fly about 5,000 test sorties over about 10,000 hours during the testing phase of the program.

BF-1 began hover-pit testing in Fort Worth, TX, in March. Lockheed Martin will send the aircraft to Naval Air Station Patuxent River, MD, to begin full vertical flight tests.

The aircraft has flown 14 times in conventional mode.⁵³

Affordability and Projected Fighter Shortfalls

An additional potential issue for Congress for the F-35 program concerns the affordability of the F-35, particularly in the context of projected shortfalls in both Air Force fighters and Navy and Marine Corps strike fighters.

Although the F-35 was conceived as a relatively affordable strike fighter, some observers are concerned that, in a situation of constrained DOD resources, F-35s might not be affordable in the annual quantities planned by DOD, at least not without reducing funding for other DOD programs. As the annual production rate of the F-35 increases, the program will require more than

⁵³ Dan Taylor, “Heinz: Transition of JSF to STOVL Mode Will Not Begin Until August,” *Inside the Navy*, June 8, 2009.

\$10 billion per year in acquisition funding at the same time that DOD will face other budgetary challenges. The issue of F-35 affordability is part of a larger and longstanding issue concerning the overall affordability of DOD's tactical aircraft modernization effort, which also includes procurement of F-22s (through FY2009, at least), and F/A-18E/Fs (through FY2012, at least).⁵⁴ Some observers who are concerned about the affordability of the F-35 in the numbers desired by DOD have suggested procuring upgraded F-16s as complements or substitutes for F-35As for the Air Force, and F/A-18E/Fs as complements or substitutes for F-35Cs for the Navy. F-35 supporters argue that F-16s and F/A-18E/Fs are less capable than the F-35, and that the F-35 is designed to have reduced life-cycle operation and support (O&S) costs.

The issue of F-35 affordability occurs in the context of a projected shortfall of up to 800 Air Force fighters that was mentioned by Air Force officials in 2008,⁵⁵ and a projected shortfall of more than 100 (and perhaps more than 200) Navy and Marine Corps strike fighters.⁵⁶ Observers concerned about the affordability of the F-35 might argue that an inability to procure F-35s in desired numbers could contribute to these projected shortfalls. Supporters of the F-35 might argue that, as a relatively affordable aircraft that can be procured in highly common versions for the Air Force, Marine Corps, and Navy, the F-35 represents the most economical and cost-effective strategy for avoiding or mitigating such shortfalls.⁵⁷ Air Force officials have testified that they wish to double F-35 purchases over the next five years to alleviate the projected Air Force shortfall.⁵⁸

Implications for Industrial Base

Another potential issue for Congress regarding the F-35 program concerns its potential impact on the U.S. tactical aircraft industrial base. The October 2001 award of the F-35 SDD contract to a single company (Lockheed) raised concerns in Congress and elsewhere that excluding Boeing

⁵⁴ For more on this issue, see CRS Report RL33543, *Tactical Aircraft Modernization: Issues for Congress*.

⁵⁵ Testimony of Lieutenant General Daniel Darnell, Deputy Chief of Staff, Air, Space and Information Operations, Plans and Requirements, before an April 9, 2008, hearing on Air Force and Navy aviation programs before the Airland subcommittee of the Senate Armed Services Committee. (Source: Transcript of hearing.)

⁵⁶ For more on the projected Navy-Marine Corps strike fighter shortfall, see CRS Report RL30624, *Navy F/A-18E/F and EA-18G Aircraft Procurement and Strike Fighter Shortfall: Background and Issues for Congress*.

⁵⁷ There have also been strong differences of opinion over how F-35 costs are calculated and presented. DOD's estimate of the total acquisition cost of the F-35 program, for example, shows the overall cost decreasing from \$299 billion in December 2006 to \$298 billion in December 2007. Some observers suggested that these figures were misleading, because the largest savings reported by DOD in the December 2007 report were achieved not by improvements in design or manufacture, but instead by moving costs from one category to another. (David Fulghum, "Dueling Analyses; Questions Remain About the Fundamental Soundness of Top Pentagon Programs," *Aviation Week & Space Technology*, April 14, 2008.) The GAO offered strong criticism of JSF cost estimates, writing that they were not comprehensive, not accurate, not well documented, nor credible. (Government Accountability Office, *Joint Strike Fighter[:]Recent Decisions by DOD Add to Program Risks*, GAO-08-388, March 2008, summarized on pp. 3-4 and addressed in detail throughout the report.) In summary, GAO noted that the JSF cost estimates did not include \$7 billion for the F136 engine, and that the official JSF cost estimates are at odds with estimates made by three independent DOD agencies. JSF supporters disputed the GAO's findings, arguing that the program office's cost models are more reliable than those used by other organizations. (Amy Butler, "Cost Question," *Aviation Week & Space Technology*, July 14, 2008.) GAO is not the only organization to question the JSF cost estimates. An internal DOD organization—the Joint Estimate Team or JET—has argued that the JSF program will cost \$15 billion more than official DOD cost projections. (Marcus Weisgerber, "'Independent' DOD Assessment Finds JSF Underfunded by \$15 Billion," *Inside the Air Force*, November 28, 2008.)

⁵⁸ John Reed, "Air Force Working To More Than Double The Pace Of F-35 Purchases," *Inside the Air Force*, July 25, 2008.

from this program would reduce that company's ability to continue designing and manufacturing fighter aircraft.⁵⁹

Similar concerns regarding engine-making firms have been raised since 2006, when DOD first proposed (as part of the FY2007 budget submission) terminating the F136 alternate engine program. Some observers are concerned that if the F136 were cancelled, General Electric (GE) would not have enough business designing and manufacturing fighter jet engines to continue competing in the future with Pratt and Whitney (the manufacturer of the F135 engine). Others argued that GE's considerable business in both commercial and military engines was sufficient to sustain GE's ability to produce this class of engine in the future.⁶⁰

Exports of the F-35 could also have a strong impact on the U.S. tactical aircraft industrial base through export. Most observers believe that the F-35 could potentially dominate the combat aircraft export market, much as the F-16 has. Like the F-16, the F-35 appears to be attractive because of its relatively low cost, flexible design, and promise of high performance. Competing fighters and strike fighters, including France's Rafale, Sweden's JAS Gripen, and the European Typhoon, are positioned to challenge the F-35 in the fighter export market.

Some observers are concerned that by allowing foreign companies to participate in the F-35 program, DOD may be inadvertently opening up U.S. markets to foreign competitors who enjoy direct government subsidies. A May 2004 GAO report found that the F-35 program could "significantly impact" the U.S. and global industrial base.⁶¹ GAO found that two laws designed to protect segments of the U.S. defense industry—the Buy American Act and the Preference for Domestic Speciality Metals clause—would have no impact on decisions regarding which foreign companies would participate in the F-35 program, because DOD has decided that foreign companies that participate in the F-35 program, and which have signed reciprocal procurement agreements with DOD to promote defense cooperation, are eligible for a waiver.

Legislative Activity for FY2010

FY2010 Defense Authorization Bill (H.R. 2647)

House

The House Armed Services Committee reported H.R. 2647 on June 18, 2009.

⁵⁹ For more information, see CRS Report RL31360, *Joint Strike Fighter (JSF): Potential National Security Questions Pertaining to a Single Production Line*, by Christopher Bolkom and Daniel H. Else.

⁶⁰ For more information, see CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Christopher Bolkom.

⁶¹ General Accountability Office, *Joint Strike Fighter Acquisition: Observations on the Supplier Base*, GAO-04-554, May 2004.

Program Funding

As of June 19, 2009, the text of the committee's report on H.R. 2647 (H.Rept. 111-166) was not posted on the Legislative Information System. The committee's summary table of actions on major acquisition programs states that the bill:

- recommends increasing the administration's request for Air Force RDT&E funding for the program by \$153.5 million;
- recommends increasing the administration's request for Department of the Navy RDT&E funding for the program by \$153.5 million;
- recommends reducing the administration's request for Air Force procurement funding for the program by \$67.0 million, and reducing the requested number of F-35As to be procured by one (from 10 to nine); and
- recommends reducing the administration's request for Department of the Navy procurement funding for the program by \$122.0 million, and reducing requested the number of F-35Bs and Cs to be procured by one (from 20 to 19).

The committee's narrative summary of the bill states:

The committee provides \$6 billion [in procurement funding] for 28 F-35s, one less aircraft each for the Air Force and Navy than the budget request, but twice the number authorized in FY09. This maintains DOD's desired year-over-year production rate [increase] of 1.75. Fifteen F-35Bs are provided for the Marine Corps, [and] four F-35Cs for the Navy [authorized in the Seapower and Expeditionary Forces Subcommittee] and nine F-35As are provided for the Air Force (authorized in the Air and Land Forces Subcommittee).⁶²

The committee's narrative summary of the bill also states:

The committee has provided increased funding for the competitive engine for the JSF in each of the past three years and is greatly disappointed that the administration chose not to submit funding for this program in its FY10 budget request. In the future, 90% of the fighters in the U.S. inventory will run on the JSF engine. We cannot afford to have an engine glitch that grounds 90% of our fleet.

Accordingly, the committee reduces the overall JSF request by a total of \$464 million and provides an overall increase of \$603 million for the competitive engine program, \$463 million for continued development and \$140 million for procurement. The bill also requires DOD to include funding for the competitive engine program in future budget requests.

The committee also includes an increase of \$129 million for Air Force JSF procurement to address a budget shortfall in JSF spares and support equipment, one of the Air Force's top unfunded requirements for FY10.

Finally, the bill fences 25% of R&D funding for the JSF aircraft until DOD submits its 30-year aircraft plan and F/A-18 multiyear procurement reports required by the FY09 NDAA, and obligates all funds for development and procurement of the JSF's competitive engine.⁶³

⁶² House Armed Services Committee summary of H.R. 2647, p. 21.

⁶³ House Armed Services Committee summary of H.R. 2647, p. 25.

Legislative Provisions

H.R. 2647 as reported by the House Armed Services Committee contains a number of legislative provisions relating to the F-35 program.

Section 242 states:

SEC. 242. INCLUSION IN ANNUAL BUDGET REQUEST AND FUTURE-YEARS DEFENSE PROGRAM OF SUFFICIENT AMOUNTS FOR CONTINUED DEVELOPMENT AND PROCUREMENT OF COMPETITIVE PROPULSION SYSTEM FOR F-35 LIGHTNING II.

(a) Annual Budget- Chapter 9 of title 10, United States Code, is amended by adding at the end the following new section:

‘Sec. 235. Budget for competitive propulsion system for F-35 Lightning II

‘(a) Annual Budget- Effective for the budget of the President submitted to Congress under section 1105(a) of title 31, United States Code, for fiscal year 2011 and each fiscal year thereafter, the Secretary of Defense shall include, in the materials submitted by the Secretary to the President, a request for such amounts as are necessary for the full funding of the continued development and procurement of a competitive propulsion system for the F-35 Lightning II.

‘(b) Future-Years Defense Program- In each future-years defense program submitted to Congress under section 221 of this title, the Secretary of Defense shall ensure that the estimated expenditures and proposed appropriations for the F-35 Lightning II, for each fiscal year of the period covered by that program, include sufficient amounts for the full funding of the continued development and procurement of a competitive propulsion system for the F-35 Lightning II.

‘(c) Requirement to Obligate and Expend Funds- Of the amounts authorized to be appropriated for fiscal year 2010 or any year thereafter, for research, development, test, and evaluation and procurement for the F-35 Lightning II Program, the Secretary of Defense shall ensure the obligation and expenditure in each such fiscal year of sufficient annual amounts for the continued development and procurement of two options for the propulsion system for the F-35 Lightning II in order to ensure the development and competitive production for the propulsion system for the F-35 Lightning II.’.

(b) Clerical Amendment- The table of sections at the beginning of such chapter is amended by at the end the following new item:

‘235. Budget for competitive propulsion system for F-35 Lightning II.’.

(c) Conforming Repeal- The National Defense Authorization Act for Fiscal Year 2008 (P.L. 110-181) is amended by striking section 213.

Section 232 states:

SEC. 232. ANNUAL COMPTROLLER GENERAL REPORT ON THE F-35 LIGHTNING II AIRCRAFT ACQUISITION PROGRAM.

(a) Annual GAO Review- The Comptroller General shall conduct an annual review of the F-35 Lightning II aircraft acquisition program and shall, not later than March 15 of each of

2010 through 2015, submit to the congressional defense committees a report on the results of the most recent review.

(b) Matters to Be Included- Each report on the F-35 program under subsection (a) shall include each of the following:

(1) The extent to which the acquisition program is meeting development and procurement cost, schedule, and performance goals.

(2) The progress and results of developmental and operational testing and plans for correcting deficiencies in aircraft performance, operational effectiveness, and suitability.

(3) Aircraft procurement plans, production results, and efforts to improve manufacturing efficiency and supplier performance.

Section 218 states:

SEC. 218. LIMITATION ON OBLIGATION OF FUNDS FOR F-35 LIGHTNING II PROGRAM.

Of the amounts authorized to be appropriated or otherwise made available for fiscal year 2010 for research, development, test, and evaluation for the F-35 Lightning II program, not more than 75 percent may be obligated until the date that is 15 days after the later of the following dates:

(1) The date on which the Under Secretary of Defense for Acquisition, Technology, and Logistics submits to the congressional defense committees certification in writing that all funds made available for fiscal year 2010 for the continued development and procurement of a competitive propulsion system for the F-35 Lightning II have been obligated.

(2) The date on which the Secretary of Defense submits to the congressional defense committees the report required by section 123 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 (P.L. 110-417; 122 Stat. 4376).

(3) The date on which the Secretary of Defense submits to the congressional defense committees the annual plan and certification for fiscal year 2010 required by section 231a of title 10, United States Code.

Section 214 states:

SEC. 214. SEPARATE PROCUREMENT AND RESEARCH, DEVELOPMENT, TEST AND EVALUATION LINE ITEMS AND PROGRAM ELEMENTS FOR THE F-35B AND F-35C JOINT STRIKE FIGHTER AIRCRAFT.

In the budget materials submitted to the President by the Secretary of Defense in connection with the submission to Congress, pursuant to section 1105 of title 31, United States Code, of the budget for fiscal year 2011, and each subsequent fiscal year, the Secretary shall ensure that within the Navy research, development, test, and evaluation account and the Navy aircraft procurement account, a separate, dedicated line item and program element is assigned to each of the F-35B aircraft and the F-35C aircraft, to the extent such accounts include funding for each such aircraft.

Section 133 states:

SEC. 133. REPORT ON 4.5 GENERATION FIGHTER PROCUREMENT.

(a) In General- Not later than 90 days after the enactment of this Act, the Secretary of Defense shall submit to the congressional defense committees a report on 4.5 generation fighter aircraft procurement. The report shall include the following:

(1) The number of 4.5 generation fighter aircraft for procurement for fiscal years 2011 through 2025 necessary to fulfill the requirement of the Air Force to maintain not less than 2,200 tactical fighter aircraft.

(2) The estimated procurement costs for those aircraft if procured through single year procurement contracts.

(3) The estimated procurement costs for those aircraft if procured through multiyear procurement contracts.

(4) The estimated savings that could be derived from the procurement of those aircraft through a multiyear procurement contract, and whether the Secretary determines the amount of those savings to be substantial.

(5) A discussion comparing the costs and benefits of obtaining those aircraft through annual procurement contracts with the costs and benefits of obtaining those aircraft through a multiyear procurement contract.

(6) A discussion regarding the availability and feasibility of F-35s in fiscal years 2015 through fiscal year 2025 to proportionally and concurrently recapitalize the Air National Guard.

(7) The recommendations of the Secretary regarding whether Congress should authorize a multiyear procurement contract for 4.5 generation fighter aircraft.

(b) Certifications- If the Secretary recommends under subsection (a)(7) that Congress authorize a multiyear procurement contract for 4.5 generation fighter aircraft, the Secretary shall submit to Congress the certifications required by section 2306b of title 10, United States Code, at the same time that the budget is submitted under section 1105(a) of title 31, United States Code, for fiscal year 2011.

(c) 4.5 Generation Fighter Aircraft Defined- In this section, the term '4.5 generation fighter aircraft' means current fighter aircraft, including the F-15, F-16, and F-18, that—

(1) have advanced capabilities, including—

(A) AESA radar;

(B) high capacity data-link; and

(C) enhanced avionics; and

(2) have the ability to deploy current and reasonably foreseeable advanced armaments.

Appendix. JSF Key Performance Parameters

Figure A-1. Joint Strike Fighter: Key Performance Parameters

	KPP	STOVL	CTOL	CV
JOINT	<i>Radio Frequency Signature</i>	Very Low Observable		
	<i>Combat Radius</i>	450 nm USMC Profile	590 nm USAF Profile	600 nm USN Profile
	<i>Sortie Generation</i>	4 Surg / 3 Sust	3 Surg / 2 Sust	3 Surg / 2 Sust
	<i>Logistics Footprint</i>	< 8 C -17 equivalent loads (20 PAA)	< 8 C -17 equivalent loads (24 PAA)	< 46,000 cu ft 243 ST
	<i>Mission Reliability</i>	95%	93%	95%
	<i>Interoperability</i>	Meet 100% of critical, top-level Information Exchange Requirements Secure Voice and Data		
USMC	<i>STOVL Mission Performance</i> <i>Short Take-Off Distance</i>	550'	N/A	N/A
	<i>STOVL Mission Performance</i> <i>Vertical Lift Bring Back</i>	2 x 1K JDAM, 2 x AIM -120 With Reserve Fuel	N/A	N/A
USN	<i>Maximum Approach Speed</i>	N/A	N/A	145 knots

Notes: JSF Joint Program Office: October 11, 2007. PAA = Primary Aircraft Authorized, ST = Short Tons, Vertical Lift Bring Back = amount of weapons/fuel that can be safely landed with.

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